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Stabilizing device, vehicle equipped therewith, and stabilizing method

The invention relates to a stabilizing device for stabilizing a vehicle with regard to driving dynamics, having presetting means for determining a setpoint yaw rate signal, having limiting means for determining a limiting yaw rate signal which represents a maximum yaw rate of the vehicle, in such a way that the vehicle remains stable while taking into account the maximum yaw rate, and for limiting the setpoint yaw rate signal to the limiting yaw rate signal when the value of the setpoint yaw rate signal exceeds the value of the limiting yaw rate signal, and having generating means for generating a steering intervention signal and/or at least one braking intervention signal by reference to the limited setpoint yaw rate signal. The invention also relates to a single-track or multitrack vehicle having such a stabilizing device and to a method with the mode of functioning of such a stabilizing device.

Such a stabilizing device is known, for example, in the context of a driving dynamics controller of a vehicle, for example of a passenger car, from the article "FDR-Die Fahrdynamikregelung von Bosch [FDR - the driving dynamics controller from Bosch]", ATZ Automobiltechnische Zeitschrift 96 (1994) 11, pages 674 to 689, editor Anton van Zanten, Rainer Erhardt and Georg Pfaff. The control concept of the known driving dynamics controller is based on the so-called single-track model in which a setpoint yaw rate is calculated from the speed of the vehicle and from a presetting steering angle which the driver presets at a steering handle. However, if an excessively large setpoint yaw rate is selected the vehicle could not travel along the desired curved path due to the wheels' frictional properties being too low or the like, for

example, if the setpoint yaw rate is limited by the driving dynamics controller. The interventions of the driving dynamics controller in the brakes and/or the engine of the vehicle take place on the basis of the limited setpoint yaw rate. In order to determine the setpoint yaw rate, the presettings of the driver of the vehicle with respect to the steering angle and the drive torque and braking torque, the estimated speed of the vehicle and the coefficient of friction of the wheels are evaluated.

Document DE 101 30 663 A1 discloses a method for preventing tilting for a vehicle in which a setpoint value for the yaw rate of the vehicle is calculated on the basis of measured input variables and compared with a measured actual value, in which case, in accordance with the comparison result, the wheel brakes of the vehicle are actuated in such a way that the actual value of the yaw rate assumes the calculated setpoint value. The input variables are, inter alia, a lateral acceleration of the vehicle which is sensed, in which case the calculated setpoint value of the yaw rate is reduced as a function of the sensed lateral acceleration if said acceleration exceeds a critical value.

Document DE 198 30 189 A1 proposes a method for increasing the lateral tilting stability of a vehicle, which method is used, inter alia, in conjunction with a system for controlling yaw moment, in which case the yaw moment controlling system adjusts the yaw rate of the vehicle to a determined setpoint value. The determined setpoint value is limited to a physically appropriate value, in which case the limiting takes place taking into account a predefined stability condition which includes, inter alia, the lateral acceleration of the vehicle.

Document EP 1 000 838 A2 also relates to a method for controlling the lateral dynamics of a vehicle with front-axle steering in which a first setpoint value for the yaw rate of the vehicle is determined on the basis of variables which represent the instantaneous movement state of the vehicle, said setpoint value corresponding to the driver's request relating to the path movement of the vehicle, said request being applied by activating a control element. In addition, under the secondary condition that the attitude angle in the region of the rear wheels of the vehicle should not exceed a specific value, a second setpoint value is determined for the yaw rate, in which case the yaw rate of the vehicle is set to the respectively lower of the two setpoint values. Depending on the driving situation, the yaw rate is set by actuating a steering angle actuator and/or at least one of the wheel brakes of the vehicle.

The object of the invention is to improve a stabilizing device or a method of the type mentioned at the beginning to the effect that a risk of tilting of the vehicle is reduced.

In order to achieve the object, with the stabilizing device of the type mentioned at the beginning there is provision for said stabilizing device to have actual value means for making available a tilt angle signal which represents the current tilt angle of the vehicle, said actual value means being embodied in such a way that the tilt angle signal contains the current tilt angle or the current tilt angle can be determined from the tilt angle signal, and for the limiting means to contain tilt angle means for determining the limiting yaw rate signal by reference to the tilt angle signal. In a corresponding way, a vehicle according to the invention and a method according to the invention are

configured in accordance with the technical teaching of a further independent claim.

The tilt angle, sometimes also referred to as the rolling angle, describes the rotational deflection of the vehicle about its longitudinal axis. Taking into account the tilt angle in the determination of the setpoint yaw rate signal which is the maximum permitted prevents the vehicle from tilting or even rolling over. The generating means are, for example, a yaw rate controller. The steering intervention signal controls, for example, a steering actuator for steering the wheels of one axle. Brake actuators are actuated using the braking intervention signal or a plurality of braking intervention signals. The stabilizing device is preferably what is referred to as a steer-by-wire controller. The stabilizing device can however also form a component of a driving dynamics controller of the vehicle.

Advantageous embodiments of the invention emerge from the dependent claims and from the description.

The stabilizing device additionally expediently takes into account the current attitude angle of the vehicle. The attitude angle is the angle between the longitudinal axis of the vehicle and the vector of the speed of the vehicle. The attitude angle signal which represents the attitude angle of the vehicle is made available by the correspondingly designed actual value means. The limiting means

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Patent Claims

1. A stabilizing device for stabilizing a vehicle (10) with regard to driving dynamics

- having presetting means (41) for determining a setpoint yaw rate signal (49) and having
- limiting means (45) for determining a limiting yaw rate signal (50) which represents a maximum yaw rate of the vehicle (10) in such a way that the vehicle (10) remains stable while taking into account the maximum yaw rate, and for limiting the setpoint yaw rate signal (49) to the limiting yaw rate signal (50) when the value of the setpoint yaw rate signal (49) exceeds the value of the limiting yaw rate signal (50), and having
- generating means (42) for generating a steering intervention signal and/or at least one braking intervention signal by reference to the limited setpoint yaw rate signal (49),

characterized

- in that said stabilizing device has actual value means (53) for making available a tilt angle signal (56) which represents the current tilt angle of the vehicle (10), which are embodied in such a way that the tilt angle signal contains the current tilt angle or the current tilt angle can be determined from the tilt angle signal, and
- in that the limiting means (45) contain tilt angle means (46) for determining the limiting yaw rate signal (50) by reference to the tilt angle signal (56), and
- in that said stabilizing device has generating means (42) for generating a steering intervention signal and/or at least one braking intervention signal by reference to the limited setpoint yaw rate signal (49).

2. The stabilizing device as claimed in claim 1, characterized in that the limiting means (45) are designed to select the setpoint yaw rate signal (49) and the limiting yaw rate signal (50) as an input signal for the generating means (42), in which case the setpoint yaw rate signal (49) is selected if its value does not exceed the value of the limiting yaw rate signal (50) and otherwise the limiting yaw rate signal (50) is selected.

3. The stabilizing device as claimed in claim 1 or 2, characterized in that the actual value means (53) are designed to make available an attitude angle signal which represents the current attitude angle of the vehicle (10), in that the limiting means (45) contain attitude angle means (47) for determining a second limiting yaw rate signal (51) by reference to the attitude angle signal, and in that the limiting means (45) are designed to limit the setpoint yaw angle signal (49) to the value of the first limiting yaw rate signal (50) made available by the tilt angle means or the second limiting yaw rate signal (51) made available by the attitude angle means, when the value of the setpoint yaw angle signal (49) exceeds the value of the first or second limiting yaw rate signal (50, 51).

4. The stabilizing device as claimed in claim 3, characterized in that the limiting means (45) are designed to select the setpoint yaw rate signal (49) and the first or second limiting yaw rate signal (50, 51) as an input signal for the generating means

(42), in which case the yaw rate signal with the lowest value is selected as the input yaw rate signal.

5. The stabilizing device as claimed in one of the preceding claims, characterized in that the presetting means (41) are based on at least one reference model of the vehicle (10).

6. The stabilizing device as claimed in one of the preceding claims, characterized in that the yaw rate signals (49 - 51) are dependent on the direction of rotation.

7. The stabilizing device as claimed in one of the preceding claims, characterized in that the actual value means (53) contain measuring means (43) and/or estimating means (44).

8. The stabilizing device as claimed in claim 3, characterized in that the estimating means (44) contain an observer.

9. The stabilizing device as claimed in one of the preceding claims, characterized in that the actual value means (53), in particular the estimating means (44) of the actual value means (53), are connected directly to the generating means (42), in which case the actual value means (53) make available input values for the generating means (42) and/or the generating means (42) make available input values for the actual value means (53).

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10. The stabilizing device as claimed in one of the preceding claims, characterized in that the limiting means (45) for determining the limiting yaw angle signals (50) are designed in such a way that the vehicle (10) does not roll over while taking into account the maximum yaw rate.

11. The stabilizing device as claimed in one of the preceding claims, characterized in that said stabilizing device has program code which can be executed by means of a control means, in particular a processor, a driving stability controller and/or a steering controller of the vehicle (10).

12. A single-track or multitrack vehicle (10) having at least one stabilizing device (25) as claimed in one of the preceding claims, having actual value means (53) and/or sensors for generating a rolling rate signal and a presetting steering angle signal and having a steering actuator arrangement (40) which can be actuated by the stabilizing device (25) and has the purpose of steering one or more wheels of an axle of the vehicle (10).

13. A method for stabilizing a vehicle (10) with regard to driving dynamics, having the steps:

- a setpoint yaw rate signal (49) is determined,
- a limiting yaw rate signal (50) which represents a maximum yaw rate of the vehicle (10) is determined in such a way that the vehicle (10) remains stable while taking into account the maximum yaw rate,
- the setpoint yaw rate signal (49) is limited to

the value of the limiting yaw rate signal (50) if the value of the setpoint yaw rate signal (49) exceeds the value of the limiting yaw rate signal (50), and

- a steering intervention signal and/or at least one braking intervention signal are generated by reference to the limited setpoint yaw rate signal (49),

characterized in that

- a tilt angle signal (56) which represents the current tilt angle of the vehicle (10) is determined in such a way that the tilt angle signal contains the current tilt angle or the current tilt angle can be determined from the tile angle signal, and
- the limiting yaw rate signal (50) is determined by reference to the tilt angle signal (56).